CLAIMS

What is claimed is:

1. A method of controlling temperature of a heat source in contact with a heat exchanging surface of a heat exchanger, wherein the heat exchanging surface is substantially aligned along a plane, the method comprising:
   a. channeling a first temperature fluid to the heat exchanging surface, wherein the first temperature fluid undergoes thermal exchange with the heat source along the heat exchanging surface; and
   b. channeling a second temperature fluid from the heat exchange surface,

   wherein fluid is channeled to minimize temperature differences along the heat source.

2. The method according to claim 1 wherein the fluid is in single phase flow conditions.

3. The method according to claim 1 wherein the fluid is in two phase flow conditions.

4. The method according to claim 1 wherein at least a portion of the fluid undergoes a transition between single and two phase flow conditions in the heat exchanger.

5. The method according to claim 1 wherein the first temperature fluid and the second temperature fluid are channeled substantially perpendicular to the plane.

6. The method according to claim 1 further comprising channeling the fluid along at least one fluid path configured to apply a desired fluidic resistance to the fluid to control the fluid at a desired temperature.

7. The method according to claim 6 wherein the fluid is channeled along one or more fluid paths, wherein each fluid path includes a flow length dimension and a hydraulic dimension.

8. The method according to claim 7 wherein the hydraulic dimension of the fluid path varies with respect to the flow length dimension.

9. The method according to claim 8 further comprising configuring the hydraulic dimension to be adjustable in response to one or more operating conditions in the heat exchanger, wherein the adjustable hydraulic dimension is adapted to control the fluidic resistance.

10. The method according to claim 7 further comprising coupling means for sensing at least one desired characteristic at a predetermined location along the fluid path.

11. The method according to claim 1 further comprising:

a. directing a first portion of the fluid to a first circulation path along a first desired region of the heat exchanging surface; and

b. directing a second portion of the fluid to a second circulation path along a second desired region of the heat exchanging surface, wherein the first circulation path flows independently of the second circulation path to minimize temperature differences in the heat source.

12. The method according to claim 7 further comprising adapting one or more selected areas in the heat exchange surface to have a desired thermal conductivity to control a local thermal resistance.

13. The method according to claim 7 further comprising configuring the heat exchange surface to include a plurality of heat transferring features thereupon, wherein heat is transferred between the fluid and the plurality of heat transferring features.

14. The method according to claim 7 further comprising roughening at least a portion of the heat exchange surface to a desired roughness to control at least one of the fluidic and thermal resistances.

15. The method according to claim 13 wherein at least one of the heat transferring features further comprises a pillar.

16. The method according to claim 13 wherein the at least one heat transferring feature further comprises a microchannel.

17. The method according to claim 13 wherein the at least one heat transferring feature further comprises a microporous structure.

18. The method according to claim 15 wherein the at least one pillar has an area dimension within the range of and including $(10 \text{ micron})^2$ and $(100 \text{ micron})^2$.

19. The method according to claim 15 wherein the at least one pillar has a height dimension within the range of and including 50 microns and 2 millimeters.

20. The method according to claim 15 wherein at least two pillars are separate from each other by a spacing dimension within the range of and including 10 to 150 microns.

21. The method according to claim 16 wherein the at least one microchannel has an area dimension within the range of and including $(10 \text{ micron})^2$ and $(100 \text{ micron})^2$.

22. The method according to claim 16 wherein the at least one microchannel has a height dimension within the range of and including 50 microns and 2 millimeters.

23. The method according to claim 16 wherein at least two microchannels are separate from each other by a spacing dimension within the range of and including 10 to 150 microns.

24. The method according to claim 16 wherein the at least one microchannel has a width dimension within the range of and including 10 to 150 microns.

25. The method according to claim 17 wherein the microporous structure has a porosity within the range of and including 50 to 80 percent.

26. The method according to claim 17 wherein the microporous structure has an average pore size within the range of and including 10 to 200 microns.

27. The method according to claim 17 wherein the microporous structure has a height dimension within the range of and including 0.25 to 2.00 millimeters.

28. The method according to claim 13 wherein a desired number of heat transferring features are disposed per unit area to control a resistance to the fluid.

29. The method according to claim 28 wherein the fluidic resistance is optimized by selecting an appropriate pore size and an appropriate pore volume fraction in a microporous structure.

30. The method according to claim 28 wherein the fluidic resistance is optimized by selecting an appropriate number of pillars and an appropriate pillar volume fraction in the unit area.

31. The method according to claim 28 wherein the fluidic resistance is optimized by selecting an appropriate hydraulic diameter for at least one microchannel.

32. The method according to claim 17 wherein the fluidic resistance is optimized by selecting an appropriate porosity of the microporous structure.

33. The method according to claim 15 wherein the fluidic resistance is optimized by selecting an appropriate spacing dimension between at least two pillars.

34. The method according to claim 13 further comprising optimizing a length dimension of the heat transferring feature to control the fluidic resistance to the fluid.

35. The method according to claim 13 further comprising optimizing at least one dimension of at least a portion of the heat transferring feature to control the fluidic resistance to the fluid.

36. The method according to claim 13 further comprising optimizing a distance between two or more heat transferring features to control the fluidic resistance to the fluid.

37. The method according to claim 13 further comprising applying a coating upon at least a portion of at least one heat transferring feature in the plurality to control at least one of the thermal and fluidic resistances.

38. The method according to claim 13 further comprising optimizing a surface area of at least one heat transferring feature to control the fluidic resistance to the fluid.

39. The method according to claim 13 further comprising configuring at least one flow impeding element along the fluid path, wherein the at least one flow impeding element controls a resistance.

40. The method according to claim 7 further comprising adjusting a pressure of the fluid at a predetermined location along the fluid path to control an instantaneous temperature of the fluid.

41. The method according to claim 7 further comprising adjusting a flow rate of the fluid at a predetermined location along the flow path to control an instantaneous temperature of the fluid.

42. A heat exchanger for controlling a heat source temperature comprising:
   a. a first layer in substantial contact with the heat source and configured to perform thermal exchange with fluid flowing in the first layer, the first layer aligned along a first plane; and
   b. a second layer coupled to the first layer for channeling fluid to the first layer and for channeling fluid from the first layer, wherein the heat exchanger is configured to minimize temperature differences along the heat source.

43. The heat exchanger according to claim 42 wherein the second layer further comprises:
   a. a plurality of inlet fluid paths configured substantially perpendicular to the first plane; and
   b. a plurality of outlet paths configured substantially perpendicular to the first plane, wherein the inlet and outlet paths are arranged parallel with one another.

44. The heat exchanger according to claim 42 wherein the second layer further comprises:

a. a plurality of inlet fluid paths configured substantially perpendicular to the first plane; and

b. a plurality of outlet paths configured substantially perpendicular to the first plane, wherein the inlet and outlet paths are arranged in non-parallel relation with one another.

45. The heat exchanger according to claim 42 wherein the second layer further comprises:

a. a first level having at least one first port configured to channel fluid to the first level; and

b. a second level having at least one second port, the second level configured to channel fluid from the first level to the second port, wherein fluid in the first level flows separately from the fluid in the second level.

46. The heat exchanger according to claim 42 wherein the fluid is in single phase flow conditions.

47. The heat exchanger according to claim 42 wherein the fluid is in two phase flow conditions.

48. The heat exchanger according to claim 42 wherein at least a portion of the fluid undergoes a transition between single and two phase flow conditions in the heat exchanger.

49. The heat exchanger according to claim 42 further comprising at least one fluid path adapted to apply a desired fluidic resistance to the fluid to control temperature of the fluid at a desired location.

50. The heat exchanger according to claim 49 wherein the at least one fluid path is located in the first layer.

51. The heat exchanger according to claim 49 wherein the at least one fluid path is located in the second layer.

52. The heat exchanger according to claim 49 wherein the at least one fluid path is located in a third layer positioned in between the first and second layers.

53. The heat exchanger according to claim 49 wherein the fluid path includes a flow length dimension and a hydraulic dimension.

54. The heat exchanger according to claim 53 wherein the hydraulic dimension is nonuniform with respect to the flow length dimension at a desired location to control the fluidic resistance to the fluid.

55. The heat exchanger according to claim 49 further comprising at least one expandable valve coupled to a wall of the fluid path, wherein the at least one expandable valve is configured to adjust in response to one or more operating conditions to variably control the fluidic resistance.

56. The heat exchanger according to claim 49 further comprising one or more sensors positioned at a predetermined location along the fluid path, wherein the one or more sensors provide information regarding the temperature of the heat source.

57. The heat exchanger according to claim 49 wherein a portion of the fluid path is directed to a first circulation path along the first layer, wherein fluid in the first circulation path flows independently of fluid in a second circulation path in the first layer.

58. The heat exchanger according to claim 49 wherein one or more selected areas in the first layer is configured to have a desired thermal conductivity to control a thermal resistance to the fluid.

59. The heat exchanger according to claim 49 wherein the first layer further comprises a plurality of heat transferring features disposed thereupon.

60. The heat exchanger according to claim 59 wherein at least one of the heat transferring features further comprises a pillar.

61. The heat exchanger according to claim 59 wherein the at least one heat transferring features further comprises a microchannel.

62. The heat exchanger according to claim 59 wherein the at least one heat transferring features further comprises a microporous structure.

63. The heat exchanger according to claim 60 wherein the at least one pillar has an area dimension within the range of and including (10 micron)^2 and (100 micron)^2.

64. The heat exchanger according to claim 60 wherein the at least one pillar has a height dimension within the range of and including 50 microns and 2 millimeters.

65. The heat exchanger according to claim 60 wherein at least two pillars are separate from each other by a spacing dimension within the range of and including 10 to 150 microns.

66. The heat exchanger according to claim 61 wherein the at least one microchannel has an area dimension within the range of and including (10 micron)^2 and (100 micron)^2.

67. The heat exchanger according to claim 61 wherein the at least one microchannel has a height dimension within the range of and including 50 microns and 2 millimeters.

68. The heat exchanger according to claim 61 wherein at least two microchannels are separate from each other by a spacing dimension within the range of and including 10 to 150 microns.

69. The heat exchanger according to claim 61 wherein the at least one microchannel has a width dimension within the range of and including 10 to 150 microns.

70. The heat exchanger according to claim 62 wherein the microporous structure has a porosity within the range of and including 50 to 80 percent.

71. The heat exchanger according to claim 62 wherein the microporous structure has an average pore size within the range of and including 10 to 200 microns.

72. The heat exchanger according to claim 62 wherein the microporous structure has a height dimension within the range of and including 0.25 to 2.00 millimeters.

73. The heat exchanger according to claim 59 wherein at least a portion of the first layer is configured to have a desired roughness to control the fluidic resistance.

74. The heat exchanger according to claim 59 wherein a desired number of heat transferring features are disposed per unit area to control the fluidic resistance to the fluid.

75. The heat exchanger according to claim 59 wherein a length dimension of at least one heat transferring feature is configured to control the fluidic resistance to the fluid.

76. The heat exchanger according to claim 59 wherein a height dimension of the heat transferring feature is configured to control the fluidic resistance to the fluid.

77. The heat exchanger according to claim 59 wherein one or more heat transferring features are positioned an appropriate distance from an adjacent heat transferring feature to control the fluidic resistance to the fluid.

78. The heat exchanger according to claim 59 wherein at least a portion of at least one heat transferring feature includes a coating thereupon, wherein the coating controls the thermal resistance to the fluid.

79. The heat exchanger according to claim 59 wherein at least one heat transferring feature is configured to have an appropriate surface area to control the fluidic resistance to the fluid.

80. The heat exchanger according to claim 49 wherein the fluid path further comprises at least one flow impeding element extending into the fluid path to control the fluidic resistance to the fluid.

81. The heat exchanger according to claim 49 wherein the fluid path is configured to adjust a fluid pressure at a predetermined location to control a temperature of the fluid.

82. The heat exchanger according to claim 49 wherein the fluid path adjusts a pressure of the fluid at a desired location to control an instantaneous temperature of the fluid.

83. The heat exchanger according to claim 49 wherein the fluid path adjusts a flow rate of at least a portion of the fluid to control a temperature of the fluid.

84. A hermetic closed loop system for controlling a temperature of a heat source comprising:

a. at least one heat exchanger for controlling the temperature of the heat source, wherein the heat exchanger is configured to minimize temperature differences in the heat source;

b. at least one pump for circulating fluid throughout the loop, the at least one pump coupled to the at least one heat exchanger; and

c. at least one heat rejector coupled to the at least one pump and the at least one heat exchanger.

85. The system according to claim 84 wherein the at least one heat exchanger layer further comprises:

a. an interface layer in substantial contact with the heat source and configured to channel fluid along at least one thermal exchange path, the interface layer configured along a first plane; and

b. a manifold layer for delivering inlet fluid along at least one inlet path and for removing outlet fluid along at least one outlet path.

86. The system according to claim 85 wherein the manifold layer further comprises:

a. a plurality of inlet fingers in communication with the inlet fluid paths, the plurality of inlet fingers configured substantially perpendicular to the first plane; and

b. a plurality of outlet fingers in communication with the outlet fluid paths, the plurality of outlet fingers configured substantially perpendicular to the first plane, wherein the inlet and outlet fingers are arranged parallel with one another.

87. The system according to claim 85 wherein the manifold layer further comprises:

a. a plurality of inlet fingers in communication with the inlet fluid paths, the plurality of inlet fingers configured substantially perpendicular to the first plane; and

b. a plurality of outlet fingers in communication with the outlet fluid paths, the plurality of outlet fingers configured substantially perpendicular to the first plane, wherein the inlet and outlet fingers are arranged in non-parallel relation with one another.

88. The system according to claim 85 wherein the manifold layer further comprises:

a. a first level having a plurality of fluid paths positioned an optimal distance from one another; and

b. a second level configured to channel fluid from the outlet fluid paths to the second port, wherein fluid in the first level flows separately from the fluid in the second level.

89. The system according to claim 84 wherein the fluid is in single phase flow conditions.

90. The system according to claim 84 wherein the fluid is in two phase flow conditions.

91. The system according to claim 84 wherein at least a portion of the fluid undergoes a transition between single and two phase flow conditions in the heat exchanger.

92. The system according to claim 85 wherein the heat exchanger applies a fluidic resistance to the fluid to control a flow rate of the fluid at a desired location in the heat exchanger.

93. The system according to claim 92 wherein each inlet fluid path and outlet fluid path includes a respective flow length dimension and a hydraulic dimension.

94. The system according to claim 93 wherein the hydraulic dimension is nonuniform with respect to the flow length dimension to control the fluidic resistance to the fluid.

95. The system according to claim 92 further comprising at least one expandable valve coupled along a wall within the heat exchanger, wherein the at least one expandable valve is configured to be adjustable in response to one or more operating conditions to variably control the fluidic resistance to the fluid.

96. The system according to claim 84 further comprising one or more sensors positioned at a predetermined location in the heat exchanger, wherein the one or more sensors provide information regarding cooling of the heat source.

97. The system according to claim 85 wherein a portion of the inlet fluid path is directed to a first circulation path along the interface layer, wherein fluid in the first circulation path flows independently of fluid in a second circulation path in the interface layer.

98. The system according to claim 92 wherein one or more selected areas in the interface layer is configured to have a desired thermal conductivity to control the thermal resistance to the fluid.

99. The system according to claim 92 wherein the interface layer further comprises a plurality of heat transferring features disposed thereupon.

100. The system according to claim 99 wherein at least one of the heat transferring features further comprises a pillar.

101. The system according to claim 99 wherein the at least one heat transferring features further comprises a microchannel.

102. The system according to claim 99 wherein the at least one heat transferring features further comprises a microporous structure.

103. The system according to claim 100 wherein the at least one pillar has an area dimension within the range of and including (10 micron)^2 and (100 micron)^2.

104. The system according to claim 100 wherein the at least one pillar has a height dimension within the range of and including 50 microns and 2 millimeters.

105. The system according to claim 100 wherein at least two pillars are separate from each other by a spacing dimension within the range of and including 10 to 150 microns.

106. The system according to claim 101 wherein the at least one microchannel has an area dimension within the range of and including (10 micron)^2 and (100 micron)^2.

107. The system according to claim 101 wherein the at least one microchannel has a height dimension within the range of and including 50 microns and 2 millimeters.

108. The system according to claim 101 wherein at least two microchannels are separate from each other by a spacing dimension within the range of and including 10 to 150 microns.

109. The system according to claim 101 wherein the at least one microchannel has a width dimension within the range of and including 10 to 150 microns.

110. The system according to claim 102 wherein the microporous structure has a porosity within the range of and including 50 to 80 percent.

111. The system according to claim 102 wherein the microporous structure has an average pore size within the range of and including 10 to 200 microns.

112. The system according to claim 102 wherein the microporous structure has a height dimension within the range of and including 0.25 to 2.00 millimeters.

113. The system according to claim 99 wherein at least a portion of the interface layer is configured to have a desired roughness to control the fluidic resistance to the fluid.

114. The system according to claim 99 wherein a desired number of heat transferring features are disposed per unit area to control the fluidic resistance to the fluid.

115. The system according to claim 99 wherein a length dimension of at least one heat transferring feature is configured to control the fluidic resistance to the fluid.

116. The system according to claim 99 wherein a height dimension of the heat transferring feature is configured to control the fluidic resistance to the fluid.

117. The system according to claim 99 wherein one or more heat transferring features are positioned an appropriate distance from an adjacent heat transferring feature to control the fluidic resistance to the fluid.

118. The system according to claim 99 wherein at least a portion of at least one heat transferring feature includes a coating thereupon, wherein the coating provides a desired amount of fluidic resistance to the fluid.

119. The system according to claim 99 wherein at least one heat transferring feature is configured to have an appropriate surface area to control the fluidic resistance to the fluid.

120. The system according to claim 92 wherein at least one fluid path further comprises at least one flow impeding element extending into the fluid path to control the fluidic resistance to the fluid.

121. The system according to claim 92 wherein at least one of the inlet and outlet paths is configured to adjust a fluid pressure along a predetermined location along a flow path to control a temperature of the fluid.

122. The system according to claim 92 wherein at least one of the inlet and outlet paths adjusts a pressure of the fluid at a desired location to control a temperature of the fluid.

123. The system according to claim 92 wherein at least one of the inlet and outlet paths adjusts a flow rate of at least a portion of the fluid to control a temperature of the fluid.